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Are dynamical charm quarks necessary?

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Lattice QCD Simulations with $N_f=2+1$ dynamical quark flavors are quite common and, due to the decoupling of the charm quark, sufficient for the study of low energy physics with energies far below the charm threshold. However when used in studies of charm physics, the quenching of the heavy quarks may introduce large uncontrolled systematic uncertainties. To assess how big these effects might be on quantities like the charmonium spectrum, the renormalized charm quark mass and the charmonia decay constants, we compare $N_f=0$ QCD with $N_f=2$ QCD, where the second theory contains two heavy quarks, with the mass of a charm quark. This setup, without the light quarks, allows us to isolate the charm loop effects to a very high precision.

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